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ABSTRACT

The study of engineering can be likened to a game. To become a master student, one must not only play the game but devote time and energy to learning how to play it. The purpose of this book is to give students ideas and perspectives which must be addressed in order to be effective students. It focuses on the nonacademic aspects of being a student. This book seeks to help students adjust their attitude and approach so that they can achieve in the science and mathematics courses they will need to master to become engineers. Discussions include: (1) motivation; (2) career awareness; (3) goal setting; (4) life structure; (5) positive focus; (6) college as an opportunity; (7) getting help; (8) developing study skills; and (9) personal care. (CW)

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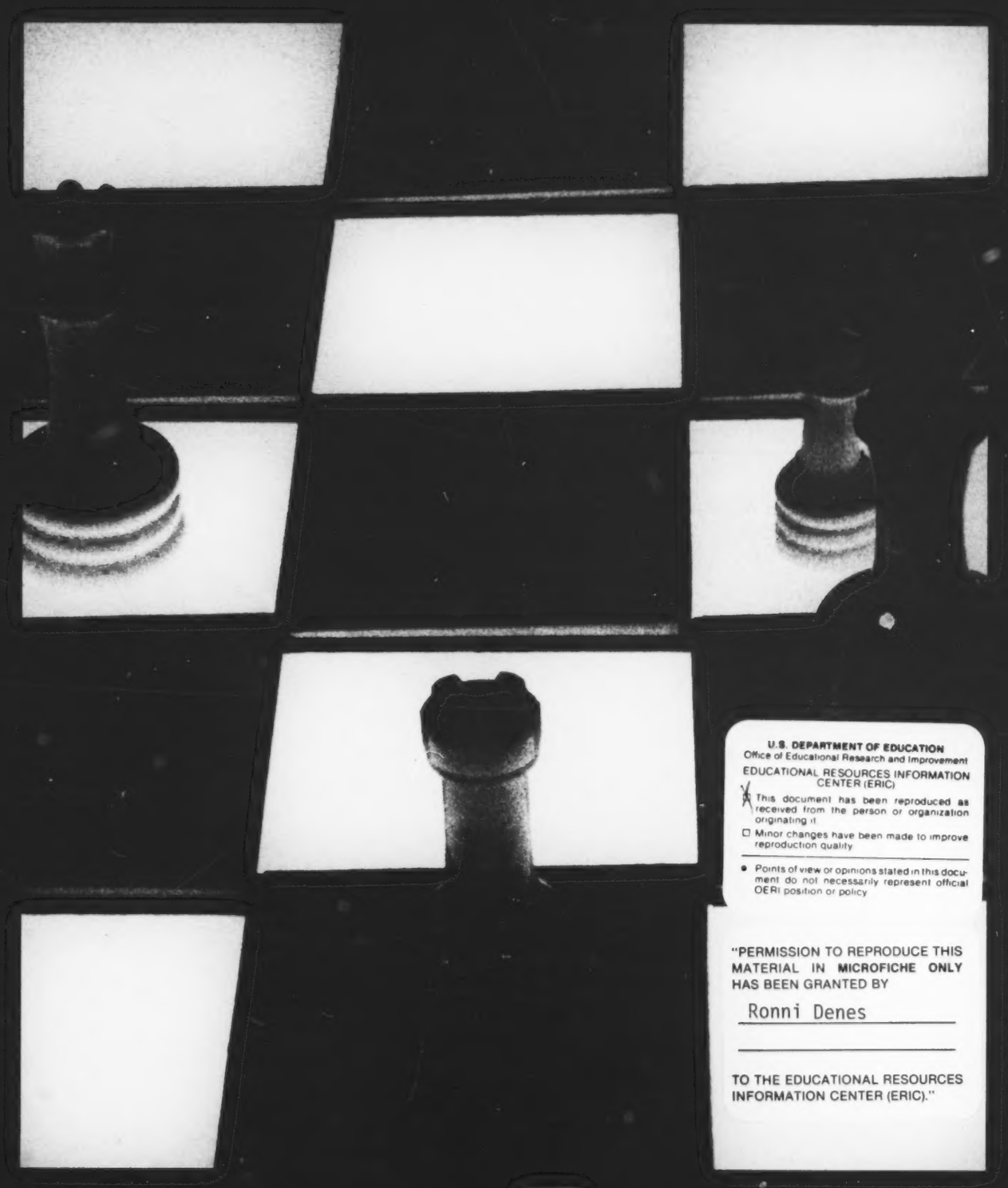
Academic Gamesmanship: Becoming a "Master" Engineering Student



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NACME

NACME is the National Action Council for Minorities in Engineering, Inc., a non-profit organization founded to act as catalyst in the minority engineering education effort. This movement, started more than a decade ago by companies, educators, professional societies and minority organizations, strives to increase the number of underrepresented minorities who graduate from accredited engineering schools.

NACME plays a key role in this effort by initiating, facilitating and developing both programs and services that make it possible for a growing pool of Blacks, Mexican Americans, Puerto Ricans and American Indians to earn bachelors degrees in engineering.

As an enabling organization, NACME achieves its goals in a variety of ways. Its Incentive Grants Program is the nation's largest privately supported scholarship fund for minorities in engineering. Its Field Services Program supports local and regional organizations with grant monies and with technical assistance in establishing and strengthening precollege and university programs. And NACME's active research and publications programs make vital information available to students, parents, educators and corporate supporters.

Academic Gamesmanship

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Academic Gamesmanship: Becoming a "Master" Engineering Student

By Raymond B. Landis
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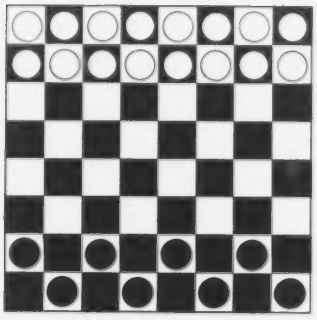

Chess

Originated in India or Persia between 400 and 600 A.D., chess is the classic game of strategy. The "master" player immobilizes or checkmates the opposing King.

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Introduction

If you were to take up a new game—chess, for example—what would you do? Learn the basic objectives, rules, and moves and then begin to play? Probably. But you'd soon discover that mastering a game of skill like chess requires much more. So you might read a book, take a lesson, watch experts play, or engage in similar activities to improve your knowledge of the game. You would realize that to become a chess "master," you need to spend time *both* playing the game *and* learning about it.

The study of engineering can be likened to a game. To become a "master" student you must not only play the game—i.e., be a student—you must also devote time and energy to learning how to play it.

The first step in playing the game of becoming an engineer is to get a clear picture of what is required to become one. You may have been told that engineers must like mathematics, be interested in how things work, or be good at visualizing objects in three dimensions. Although skills in these areas are certainly useful, having them alone doesn't make a person an engineer, and many excellent engineers are not strong in all these areas.

So what is required to be an engineer? Very simply, you become an engineer when you graduate with a degree in engineering. And what does that mean? It means you have passed a prescribed set of courses—which, in turn, means you have passed each course in the prescribed set. And what is required to pass each course? Mostly passing a series of tests or exams. And to pass a series of tests, you must pass each test one at a time. So by breaking it down this way, you can see that to become an engineer you must become a master at preparing for, taking, and passing tests.

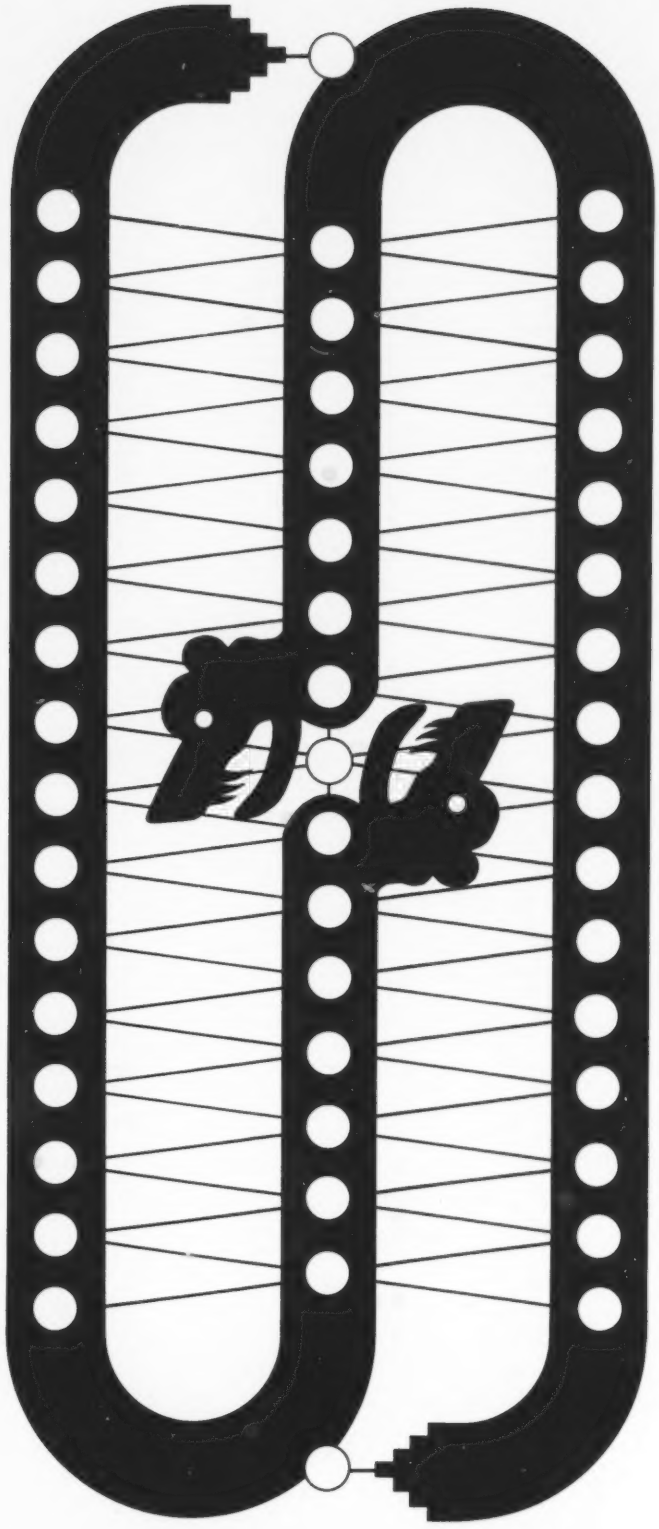
Of course this is easier said than done, as many other factors are involved. You must get your life situation together so that you are not overburdened with problems and distractions. You must develop a high level of commitment and motivation so you are willing to make the necessary choices and personal sacrifices. You must appreciate the value of a technical education and know why you want to be an engineer. You must learn how the educational system works and how to be effective as a student.

The purpose of this book is to give you some ideas and perspectives on these and other issues which you must address in order to be an effective student. The book focuses on the non-academic aspects of being a student. It will not increase your knowledge of mathematics or chemistry or physics, but it can aid you in adjusting your attitude and approach so that you will be able to learn these subjects.

The ideas presented here will not be absorbed by one reading nor, in fact, is it sufficient merely to understand them intellectually. Rather, if they are to benefit you, you must set out on a process of internalizing as many of them as suit your particular needs. This process will only occur over time and only by repeated reinforcement through self study; discussion with friends, peers, parents, or mentors; and experimentation.

Fighting Serpents

The Zuni Indians in sixteenth century New Mexico played Fighting Serpents on the flat roofs of their homes. To win, a player captures the opposition's 23 pebbles or pottery shards.



1

Develop a Clear Picture of Why You Want an Education: Motivate Yourself

Why do you want an education? Perhaps you are doing it to please your parents or because you don't know what else to do. How important is it to you to graduate? How strong are your motivation and commitment?

Even the most brilliant student will not succeed without a high level of commitment. Over my years of working with students I have seen many highly capable students fail. I also have seen many students with average or even below-average ability make it. The difference is determination.

The fact that you have been accepted by your university as an engineering major is a strong indication that you can make it. The only obstacle that will keep you from succeeding is you. You must believe in yourself, believe that you can do it. Take on a positive, determined attitude. Know that you can make it. Astronaut Ron McNair, a victim of the tragic Space Shuttle accident, gave a wonderful and inspiring talk at the 10th Anniversary Banquet of the Minority Engineering Program at California State University, Northridge. He compared his graduate study at MIT to a five-round fight. He was knocked down several times but he picked himself up and in the end he was victorious. The point is that even the most successful people experience setbacks and failures. They achieve success because they refuse to let setbacks stop them. Like a fighter who gets knocked down, don't let setbacks defeat you. Believe in yourself, motivate yourself, be persis-

tent and determined, and you, too, will be victorious in the end.

Where do you get your commitment? How do you motivate yourself when the going gets tough? One thing that helps is to keep in mind a clear picture of why you want an education. Define for yourself what you expect your education will do for you.

If your ideas about the value of an education are vague, try asking educated people what their education means to them. Sometimes I feel frustrated when I see students who are blowing their chances for an education. I want so much to have them know how much my education has meant to me. I have had so many unique and rewarding experiences, so many challenges, so many opportunities. I've been paid well to do work I enjoy. I have been able to travel, write, speak, teach, and influence others. I have gotten to know many interesting people. I have had options and choices and control over where I live and what I do. I can hardly imagine going through life without an education.

Applying yourself to getting an education is an invaluable investment in your future. At Cal State Northridge, each participant in the Minority Engineering Program is given a motivational button with the logo shown below. The clenched fist holding the slide rule symbolizes the power that comes to an individual through a technical education.

The motto "No deposit, no return" reminds us, however, that this power does not come without a "deposit." Getting a college education is not easy, and majoring in engineering is even more difficult. Without a doubt, the "deposit" you must make as an engineering major is a rigorous, demanding one. But I guarantee that you will be paid back for that investment many, many times over

2

Learn as Much as Possible About Engineering as a Career

An important aspect of developing your commitment to engineering study is increasing your awareness of engineering as a profession and the opportunities and rewards which you will receive if you are successful in graduating. After all, how can you expect to make the necessary "deposit" unless you have a clear picture of what the "return" is and what it will do for you?

I am often asked the question, "What is engineering?" I must admit, I still have difficulty responding. The reason is that engineering is so many different things. The standard definition is that engineering is

> *"the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind."*[1]

But engineers do so many different things and perform so many different functions that no simple definition is adequate.

You are probably aware that engineers are classified by their fundamental academic area. We have electrical engineers, mechanical engineers, civil engineers, chemical engineers, and in-

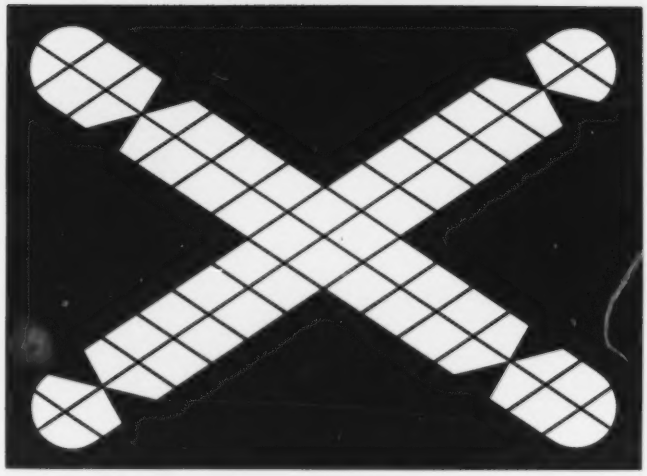
[1]Definition formulated by The Accreditation Board for Engineering and Technology (1982), contained in *Engineering as a Career* by Ralph J. Smith, Blaine R. Butler, and William K. Le Bold (New York: McGraw-Hill, Inc., 1983), page 8.

dustrial engineers. These are the five largest so-called "traditional" areas of engineering. There are also more specialized, non-traditional fields of engineering.

Nuclear engineers, petroleum engineers, biomedical engineers, ocean engineers, aerospace engineers, and mining engineers are examples of these. Unless you have a strong interest in one of the non-traditional areas, I would suggest at the undergraduate level that you stick with one of the traditional areas. Job opportunities in the non-traditional areas tend to have more extreme ups and downs, whereas with an electrical engineering degree, for example, you are qualified to work in the aerospace, nuclear, biomedical, or numerous other industries.

Engineers are also classified by job function. We have analytical engineers, design engineers, test engineers, development engineers, sales engineers, and field service engineers. The work of analytical engineers most closely resembles what you do in school. But only about ten percent of all engineers fall into this category, pointing out that engineering *study* and engineering *work* are generally quite different. If you are imaginative and creative, design engineering may be for you. If you like laboratories and conducting experiments, you might consider test engineering. If you like to organize and expedite projects, look into becoming a development engineer. If you are persuasive and like working with people, look into sales or field service engineering.

If you are successful as an engineer and have strong leadership skills, within a few years of graduation you could very well move into management. Opportunities exist primarily in two areas: line management and project management.



Patolli

Invented by the Aztec Indians some time before the Spanish conquest of Mexico in 1521, Patolli was a favorite gambling game. To win the stakes and forfeits, a player must be first to remove all pieces from the board.

In a company, the technical staff is organized into an engineering "line" organization. Ten to fifteen engineers are managed by a unit supervisor; several units are managed by a group manager. This organizational line goes on to department managers, to the chief engineer or engineering vice president, and finally to the president. Often the president of a technical company is an engineer who worked his or her way up through the line organization.

Project management is a little different, as the staff is organized according to a specific project or assignment. At the head of each project is a project manager. For a small project, the project manager may oversee the entire project; for larger projects, the project manager will be assisted by a project management staff which could range in size from one person to several hundred people. The role of the project management staff is to see that the project is completed successfully, on time, and within budget. One of their major responsibilities is to oversee the work of engineers assigned to their project from the line organization.

Your engineering degree can lead you to many other career paths. Law schools and medical schools consider an engineering degree excellent preparation for the rigors of their programs. A master's degree in business administration (MBA) following an undergraduate degree in engineering is excellent preparation for careers in management, marketing, and sales. Graduate study in engineering can lead you into research work in industry or a rewarding career in university teaching.

The important point is that engineering is not one thing but represents a broad range of opportunities, each requiring different attributes and each offering different rewards. This section is in no way intended to give a complete presentation on engineering as a career but merely to stimulate your interest in learning more about the varied opportunities.

Learning about engineering will be a lifelong process but it should begin now. Take advantage of every opportunity that presents itself. Attend seminars, go on field trips to industry, talk to industry representatives at career day programs. Learn from your professors. If you have a summer job in a company, be curious and inquisitive. Look around. Talk to the engineers and find out what they do. Over time, this process will increase your understanding of engineering. Increased knowledge will bring increased motivation. We tend to like things that we know a lot about.

3

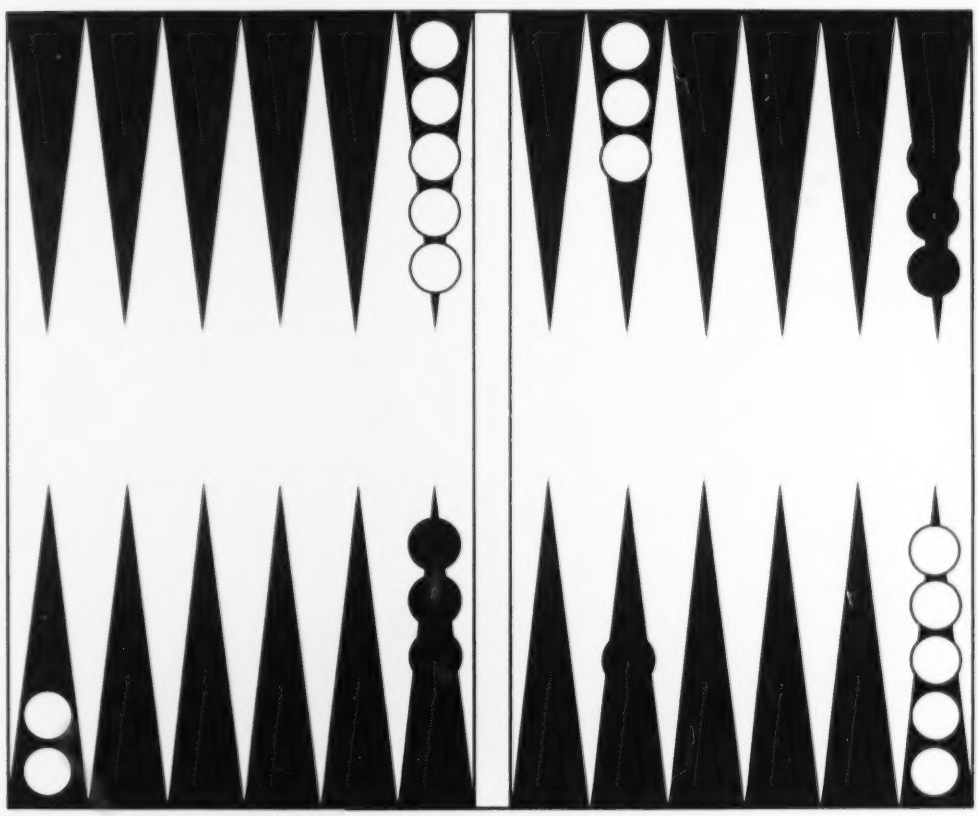
Set Goals For Yourself

Obvious though it may sound, setting goals—having a clear idea of what you want to accomplish in both the short and long-term—is a key requirement to becoming an effective student and a successful professional. Only when you set goals will you have something against which to measure yourself.

Consider, for example, two engineering students in a calculus class who score a "B" on their first exam. One student is extremely unhappy and resolves to study much harder for the next test. She has set a goal of earning an "A" in the course, and by falling short on the first test, she knows that she must work more. The other student, however, is content with the "B" grade and decides that he may be able to increase his work hours since even less study is necessary than he has been doing. These different behaviors are the result of different expectations, of the two students having different goals for themselves. As this case of the two students illustrates, success or failure can only be measured according to self-imposed goals.

Astronaut Franklin Chang-Diaz tells one of the most motivational stories I have ever heard. Chang-Diaz was born and grew up in Costa Rica. As a child he was enamored of the U.S. space program. He and his friends built spacecrafts out of cardboard boxes, equipping them with broken radios and furniture. They would go through a count-down and lift-off and pretend they travelled to a distant planet. Because of his interest, he set a personal goal of becoming a U.S. astronaut! Imagine a young Costa Rican citizen who didn't speak a word of English aspiring to be a U.S. astronaut. When he finished high school he worked for a year and saved enough money to buy a one-way airplane ticket to Hartford, Connecticut where he had some distant relatives. In Hartford he repeated his senior year of high school, learned English, and was admitted to the University of Connecticut where he majored in engineering. After graduating with honors, he began graduate study at MIT, eventually receiving his Ph.D. in plasma physics. He then applied for the astronaut program, was accepted, and became the first Hispanic astronaut. He flew his first space shuttle mission in January, 1986.

The point that the story of Dr. Chang-Diaz drives home so convincingly is the need to have goals. For how can you expect to get someplace if you don't know where it is you want to go? This is something you must define



for yourself, just as Dr. Chang-Diaz did for himself.

Right now your most important goal is to graduate with your degree in engineering. But what else would you like to accomplish? Become president of your own company? Make a million dollars? Become a college professor? And what about your more immediate goals? Maybe you want to make a 3.0 GPA next semester, improve your writing skills, or become president of one of the engineering student organizations.

I would suggest that you go through an exercise of writing down short term, intermediate term, and long term goals. Consider what you want to accomplish in the next week, in the next month, in the next year, in the next five years. Review these lists regularly and revise them as necessary. Measure yourself against your goals and adjust your behavior to bring your actions in line with them.

Make meeting your goals important to you. Above all, make the goal of graduating with a degree in engineering your number one priority. Few other accomplishments will have such a profound, positive effect on your life.

Backgammon

Thought to have been invented in Persia between 226 and 241 A.D., Backgammon is now played throughout the Middle East, Europe and North America. Win by racing your pieces around and off the board before your opponent.

4

Structure Your Life Situation: Don't Program Yourself for Failure

Setting a goal is easy. Most people would like to be rich, to be successful, to have good personal relationships, and so forth. The difficult part is to act in such a way as to ensure that a particular goal is reached. People who want to have a lot of money, for example, must behave in such a way as to bring this about. They must concentrate on such matters as preparing themselves to be able to earn money and learning how to invest wisely. They may need to defer their immediate desires—such as buying a car, taking a vacation, or having children—in pursuit of their longer term, more important goal of acquiring and building wealth.

In like manner, setting a goal of graduating in engineering is easy. Making it happen is the hard part. One of the most difficult but important aspects of being a successful student is to structure your life situation so that school can become your number one priority. To be a full-time engineering student is a major commitment. If you devote the appropriate amount of time and effort to your studies, you will have limited time or energy for other obligations.

There are a number of factors outside of school—family, friends, work, commuting—that can make major demands on you. It is imperative that you do whatever is necessary to minimize the impact of these factors. I often see students who are taking a full load of math/science/engineering courses, commute over an hour each way to school, work 20 hours a week, have a family that expects them to help out around the house, and try to maintain an active social life. Many students in this situation are very likely programmed for failure.

Each person has unique pressures and constraints on his or her life. Some of them you cannot control, but many you can. You may feel, for example, that you must have a car, that you must work, that you must live at home. You may feel that you need to dress well or have a stereo. But these needs can conflict with your goal of getting an education. In order to be successful in school you may be forced to make some difficult decisions. Pay particular attention to the following factors. They are ones that I've seen repeatedly cause students problems.

Living Arrangements.
If at all possible, live on or near the university campus. The more immersed you can get in the university environment, the better your chances of success will be. Commuting takes time, energy, and money; and living at home can present distractions. Parents may expect you to help around the house. Little brothers and sisters may be noisy and distracting. Neighborhood friends may not understand your need to study. Above all, whether you live at home or on campus, this is a time in your life when it's appropriate to be a bit selfish. Place a high value on your time, and learn to say no when necessary.

Part-Time Work.
Full-time engineering study is a full-time commitment. Working up to 10 hours a week is probably okay, but more is almost certain to take its toll on your academic performance. While it may be essential for you to work, it may also be that you are working to afford a nice

car, stereo, or other non-essentials. Look at it this way: you may get a job for $5 an hour, but in doing so you jeopardize your education or at best extend the time to graduation. When you graduate you will make at least $15 an hour. So try to delay as many material wants as possible. You will have much more in the long term.

Influence of Friends, Family.
Friends and family may not understand the demands of engineering study and may unintentionally distract you. Have a frank talk with your parents. Let them know that you want to make school your number one priority. Ask for their help, and negotiate clear agreements about their demands on you.

If you are a recent high school graduate, dealing with friends from high school—especially those who are not pursuing an education—may be a problem for you. They may put pressure on you to spend as much time with them as you did in high school, while you may find that you have less and less in common with them. Ideally, you should concentrate on developing relationships with students who are engaged in the same course work as you. This will benefit you since they will support you in your academic endeavors and you will no longer have to separate your academic life from your social life.

5

Focus on The Positive Aspects of Being a College Student

I like to make an analogy between jogging and going to college. People take up jogging because they perceive certain benefits. They expect to live longer, feel better, breathe easier, lose weight. Initially they may dislike the experience of jogging, suffering through it solely for the end result. Eventually, however, most joggers learn to enjoy the experience. They come to enjoy the physical elements of jogging—the rhythmic cadences of moving and breathing, the harmony between body and mind—and they find that long periods of jogging can lead to particularly unique experiences: the so-called "runners' high," a heightened sensitivity to the world around them, an ability to think creatively and imaginatively.

Engineering students are often like joggers. At first they may resent or dislike the college experience but persevere because of the future benefits they anticipate: career opportunities, money, social status, security. But they eventually come to appreciate their schooling, not only for the benefits it promises but for the experience itself.

If, like the novice jogger, you find that you dislike school, you are not focusing on the positive aspects of being a college student. You need to recognize that you have created an attitude that may have nothing to do with reality. In fact, you probably are in the best situation of your life and just not aware of it. Surely you have heard people say that their college years were the best years of their lives. Why do you suppose they say this?

If you do have a negative attitude toward school, now is the time to change it. For it's more than likely that you are neither performing at your peak effectiveness nor enjoying what should be a most exciting, rewarding time in your life. Learn to focus on the positive aspects of being a college student. Some of the most significant of these aspects are:

Growth Period.
As a college student, you are in an unusually heavy growth period. One indication of this is the way in which you are "outgrowing" your friends from high school who are not going to college. Probably never in your life will you be in such an intense period of learning and experiencing new things as when you are in college.

Exposure to People.
You are in an extremely people-oriented environment. Never again will you be with so many people of the same age and interests as when you are in college. The friends you make during your college years will be important and helpful to you throughout your life.

Manager of Your Time.
As a college student you are working for yourself. You have no boss, no one to tell you what to do. Except for your class time, you are pretty much free to manage your time and your affairs.

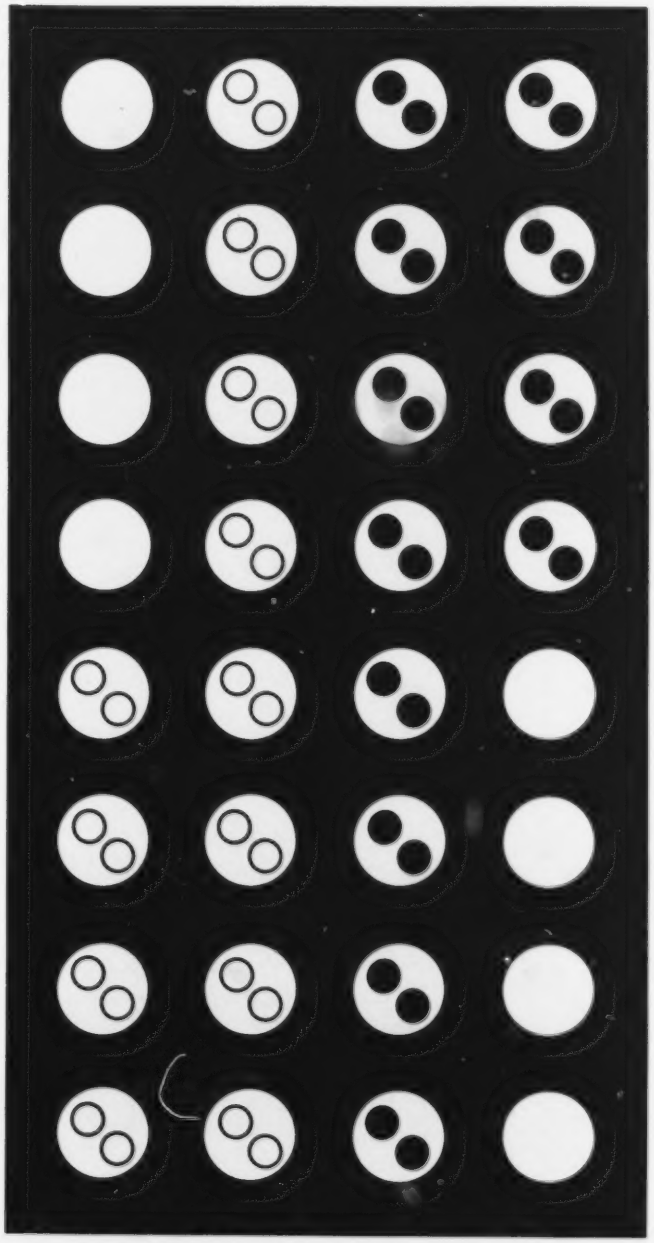
Starts and Stops.
School starts and stops, somewhat like the running of a race. When the race starts you put out a great deal of

effort, maybe more than you would like to, but you do so because you can see that it will end. When it does end, you then have an extended period of time for rest and rejuvenation—a break you will not have once you start working as an engineer.

When you learn to appreciate these and other unique aspects of being a college student, you will see an improvement in your academic performance. Remember that positive attitudes bring positive results; negative attitudes bring negative results.

Mancala

Although it was probably invented in ancient Egypt, Mancala is played in different forms through most of Black Africa. A complex game in which pebbles are used as counters, Mancala is won by the player who ends the game having the most counters.



6

View College as Your Opportunity to Prepare for Your Future

One of the most positive and unique aspects of your college experience is that it is a period of time when you are working for yourself with the objective of preparing yourself for your future. You should therefore realize that whenever you take the easiest instructor, avoid a course because you feel weak in that area, cut a class, or make any conscious choice to avoid learning, growing, or developing yourself, you are not getting away with something—you are working *against* yourself.

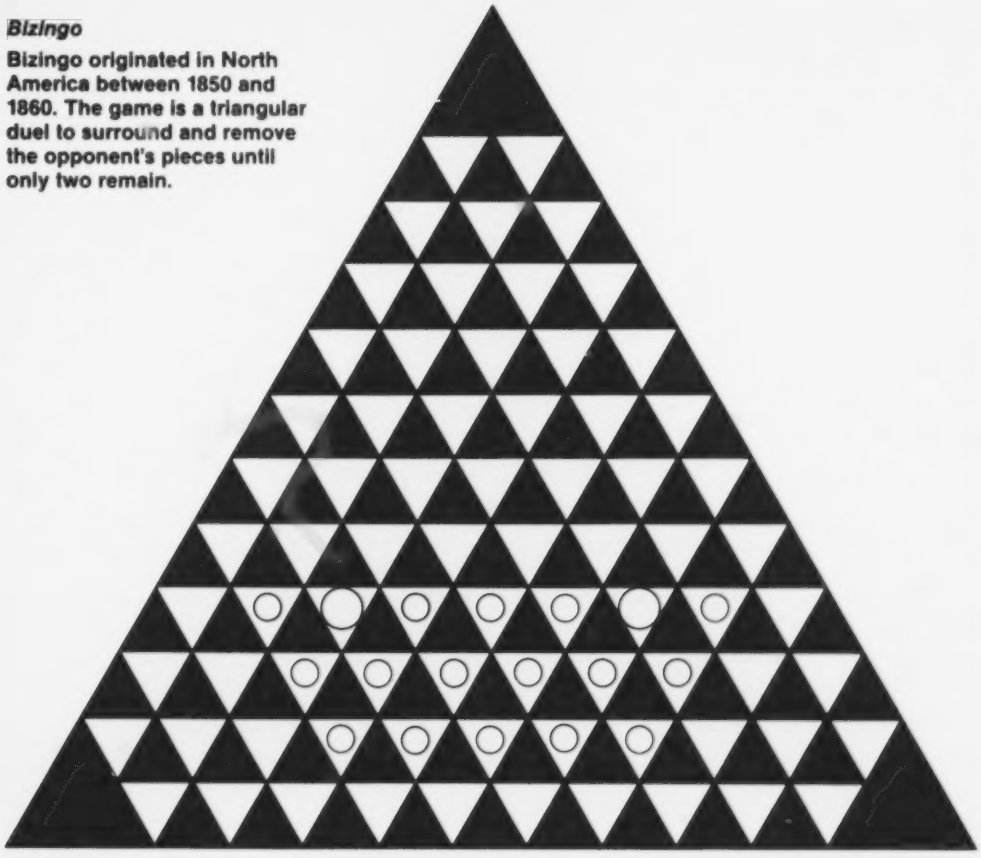
Certainly one reason you have chosen engineering as a major is the availability of jobs. In view of this, you need to consider what factors are important to employers and work to develop yourself in these areas. In a recent study, employers ranked the following as key to selecting individuals for employment:

1. Personal qualifications including maturity, initiative, enthusiasm, poise, appearance, and ability to work with others.
2. Scholastic qualifications as shown by grades in all subjects or in a major field.
3. Specialized courses related to a particular field of work.
4. Kind and amount of part-time or summer employment while in college.
5. Experience in campus activities, especially participation and leadership in extracurricular life.

As you near the graduation point, you will undoubtedly participate in a number of interviews with prospective employers. How you fare in these interviews depends

Bizingo

Bizingo originated in North America between 1850 and 1860. The game is a triangular duel to surround and remove the opponent's pieces until only two remain.



on how well you have prepared yourself between now and then in the above areas. To be strong in each area, you must make a conscious commitment to make it happen.

Personal Qualifications. You may be surprised to learn that personal qualifications, not grades, are the number one factor in evaluating candidates for employment. Probably the most important factor related to personal qualifications is the ability to work with and communicate effectively with people. It could be that you already are strong in this area, but most of us have room for improvement. Self-assessment is important. Most of us know whether we get along well with others and whether we are effective communicators. The problem is that, if we are weak in the area of personal relations, we tend to avoid people and to be shy and withdrawn, giving us no chance to improve.

If you are weak in this area, commit firmly to changing yourself. You may feel that change is not possible, but that attitude is a cop-out. It may be safe, but it is non-constructive and simply *not* true. We have learned to be the way we are because of our environment and circumstances, and if we decide we want to change, we *can* learn to behave differently.

One way to work on your interpersonal skills is to seek counseling at your university counseling center. Highly trained professionals are available to assist you through either individual counseling or personal growth groups. Another way is to take certain classes designed to improve your interpersonal and communication skills. These include acting, speech, and writing classes, as well as courses in interpersonal communication and counseling offered by your psychology or educational psychology department. Improvement will also come with practice. Go out of your way to talk with other students, professors, and professional engineers. Join various clubs or student organizations and become involved.

Scholastic Qualifications. Grades *are* important. When I interviewed for my current position, I was asked to submit transcripts of all my college work, and I had completed my undergraduate work 22 years before! When you interview for your first job, you probably will be asked to submit transcripts, but certainly will be asked your grade point average. Unlike the other factors which are qualitative and difficult to evaluate, your grade point average is quantitative and therefore may get more emphasis than it really deserves. If your grade point average is below a certain level, some employers will eliminate you from consideration solely on that basis. Whether this practice is proper or fair is irrelevant; it is a reality you have to face.

Technical Specialty. Since technology rapidly changes, the demand for technical specialties likewise changes. Fortunately, as an undergraduate, you will not achieve a high level of specialization or else your choices would be even more difficult. It is hard enough merely to decide that engineering is for you and even more so to decide what field of engineering to go into. The difficulty of this choice varies from one school to the next since some have a highly specialized curriculum allowing the decision to be postponed until the junior or even senior year. But at some point, even after you have chosen your specialty—say, for example, electrical engineering—you still will be required to choose further among electronics, computer engineering, communications,

controls, microwave, and so forth. My advice is to postpone specialization as long as your curriculum will permit. In time, you will be in a better position to choose because you will gain insights and information through more advanced course work, summer or part-time work experiences, and discussions with other students, professors, and engineers.

Pre-Professional Employment.
A company considering you for employment likes to see that you have had previous work experience, preferably in engineering-related fields. Work experience not only demonstrates interest, initiative, and commitment on your part; it also provides you with references—people you have worked for who can vouch for your abilities. Prospective employers also feel that the experience you have gained will reduce the time it takes for you to become productive in their environment.

Pre-professional employment can take the form of summer jobs, part-time work, or even a six-month-on, six-month-off cooperative education ("co-op") experience. Obtaining a position will take effort on your part, as there are generally fewer jobs available than the demand. As a freshman or sophomore you will have even more difficulty because companies generally prefer juniors and seniors—students closer to graduation.

To increase your chances of landing a summer job, take an aggressive, comprehensive approach. Prepare a resume and cover letter and send it to local companies. Follow-up with telephone calls. Be persistent. Participate in any interview opportunities through your office of career planning and placement. Check with the staff of your minority engineering program for leads. Attend any job fairs or career day programs held on your campus and try to establish personal relationships with the industry representatives there. Be friendly and sell yourself—maybe wrangle an invitation to visit their facility. Talk with students who have worked during previous summers and get them to recommend you to their supervisors. Ask engineering faculty if they have any industrial contacts. Take the positive, assertive attitude that if anyone is going to get a job, it's going to be you.

Extracurricular Activities.
Participation in extracurricular activities can benefit you in many ways. It can enhance your college experience, assist you in meeting people, develop your leadership and organizational skills, and give potential employers a concrete indication of your ability to work with and lead people. A word of caution, however: be selective about your involvement in such activities, since the opportunities to participate are so numerous that you could wind up neglecting your studies.

A good place to start is with your minority engineering student organization. Student chapters of the Society of Hispanic Professional Engineers (SHPE), the National Society of Black Engineers (NSBE), American Indian Science and Engineering Society (AISES), and others may exist on your campus. If not, help get one started. Your participation in minority engineering student organizations can be especially rewarding as it will bring you in contact with other students whose backgrounds and goals are similar to your own. Through active involvement and acceptance of leadership positions in the organization, you will learn how to work effectively with others to accomplish objectives. Also, through the organization's contact with industry you will benefit from exposure to speakers, visits to technical facilities, and summer job opportunities. Remember these are *your* organizations and they will only be as successful as you make them. So be sure to do your part.

Another excellent opportunity for participation is in student chapters of professional engineering societies, which exist in every engineering specialty. Examples are the Institute of Electrical and Electronic Engineers (IEEE), the American Society of Mechanical Engineers (ASME), the American Society of Civil Engineers (ASCE), and the American Institute of Chemical Engineers (AIChE). Although these organizations sponsor social and recreational activities, their primary focus is professional. They generally sponsor speakers, conduct field trips to industry, or coordinate competitive student projects. A number of these student projects have become quite spirited competitions, drawing a significant amount of attention on the campuses where they are held. You may already be familiar with some of these, such as the IEEE's "Micro-mouse," ASME's "Mini-Baja" car and human powered vehicle, and ASCE's concrete canoe.

Finally, there are certain types of extracurricular activities that you might consider for your own personal development or for strengthening specific talents. These include writing for your campus newspaper, joining the debate club, or participating in musical or dramatic productions.

And don't forget student government—another excellent opportunity for personal growth and development. Eventually you may want to run for one of the many elected offices, but many positions are appointed. Go to your associated student office and ask how you can become involved. Who knows, maybe in a few years you'll be running for student body president!

7

Don't be Hung Up on The Idea of Seeking Help

Do you feel that seeking help is a sign of weakness? That if you "make it" on your own you will get more out of your education? The idea that we can make it through life without help from others is a myth. When we are born we are totally dependent on our parents for our very survival. Most of what we learn we are taught by others—parents, teachers, peers. By using a scientific textbook, we benefit from the many authors who have evolved the subject over years to the point where we can readily understand it. We truly are dependent on others to live, grow, and thrive, and people who believe that they can succeed on their own are deceiving themselves. Don't let such misconceptions stand in your way. Instead, maximize the educational opportunities your campus offers you. The really smart student does.

At the university there are three primary sources available to help you with your academic work: your peers, instructors, and tutors. To become a "master" student, you must learn to use each of these effectively.

Making Effective Use of Your Peers.
Your peers can significantly influence your academic performance, either positively or negatively. Negative peer pressure against those who apply themselves to learning is an age-old problem. Derisive terms like "wimp," "nerd," "geek," "bookworm," and "poindexter" are but a few of those which are used to exert social pressure on the serious engineering student. You may have experienced this type of peer pressure in high school if your friends were not so serious about their academics as you were, and you may have been forced into a pattern of studying alone—separating your academic life from your social life. The "lone-wolf" approach to your academics may have worked for you in high school, but it is doubtful that it will work for you in engineering study where the concepts are much more complex and the pace much faster.

I would urge you to strive to integrate your social life with your academic life. Start by developing study groups with one or several students in your classes. Group study, you will find, has a number of advantages. It is an effective way to learn since several points of view on the subject are brought to bear. By explaining the subject matter to others, you will gain understanding. Group study also allows you to meet your social needs while you are learning. When I was working on my Ph.D., a close friend of mine and I took most of our courses together. To prepare for exams, typically we would meet early on a Saturday morning in an empty classroom and take turns at the blackboard deriving results, discussing concepts, and working problems. Before we knew it eight or ten hours would pass. There is no way I would have spent that amount of time studying alone on a Saturday. Lastly, group study provides you with practice in working and communicating with other people. This is excellent experience for working in industry where, as we noted earlier, the ability to work with other people is critical.

Strategies For Using Your Professors.
Your professors represent an extremely valuable resource to you. They can provide you with individual help in your courses; give you advice about the curriculum, regulations and procedures, and careers in engineering; can write letters of recommendation for you; and be supportive in numerous other ways. But your professors can only assist you if you take the initiative to seek them out.

The first step in making effective use of your professors is to overcome any fear or intimidation of them you may feel. Being awed by your professors is a natural first reaction since they are older and better educated, and often project a confident "know it all" attitude. As a result, you may think that your professors don't care about you or even that they are against you. But this is probably not true. After all, most professors chose teaching because they like teaching and working with students. And remember that professors are human beings just like you, that they have similar needs, fears, and insecurities as you. They may very much need to be liked, want you to think they are good teachers, need to impress you with their knowledge, or fear that they might make a mistake and reveal that they don't have a total command of their subject matter.

Rather than fear your professors or view them as adversaries, try to develop personal relationships with them. Begin with the goal of having each of your professors know you by name. To do this, increase your visibility. Ask questions in class. Speak to the professors after class. Remind them of your name until you're sure that they know it.

Next, take advantage of your professors' office hours. At most universities, professors are required to schedule a certain number of hours when they are in their offices and available to students. Make up some specific questions to ask, either related to engineering or of a

Go

While originated by the Chinese about 2000 B.C., GO became extremely popular in both Japan and Korea. The winning player uses logic to capture and defend territory.

more general nature. Most professors love to talk about themselves. Ask them where they went to college, how they chose their technical specialty, how they got into teaching. Professors also love to give advice. Ask them how to study more effectively, how to learn more about engineering as a career, whether you should work part-time, or even how to deal with a specific personal problem. The next thing you know they will be wanting to show you their laboratories, inviting you to their homes for dinner, or offering to help find you a summer job.

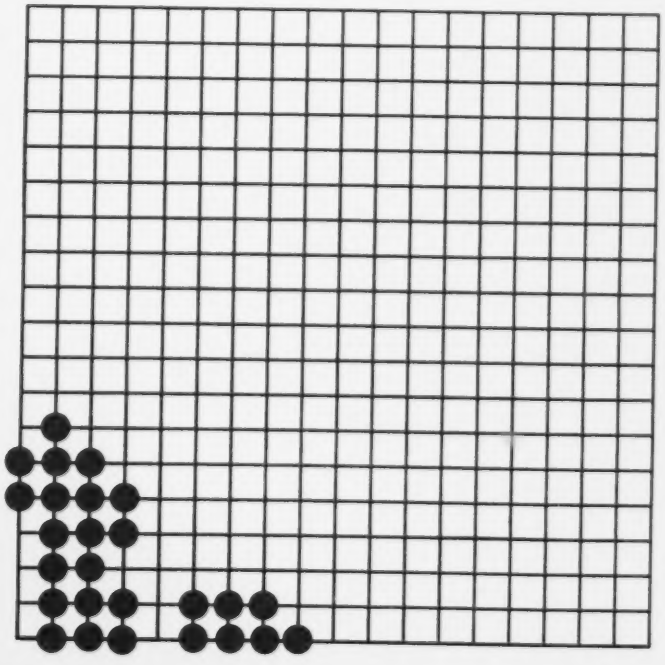
Without question, the best way to learn is to engage in a one-on-one dialogue with an expert in the subject. This is one of the oldest and most effective forms of teaching and is known as the "Socratic method" because it was the primary form of teaching used by the Greek philosopher Socrates. Our present system where one teacher lectures to 30 (or sometimes 300!) students is obviously not most effective for the learning process, but is the way we do it to be cost-effective. Having one teacher for each student would be ideal, but it would be too expensive. The primary advantage of the Socratic method is that, through the dialogue between the teacher and student, the teacher can know at once whether the student understands and can adjust his or her approach accordingly. I would encourage you to seek every possible opportunity for this kind of teaching. Tell your professor that you would like to have some one-on-one instruction. Don't worry if the professor initially acts a bit impatient with your lack of understanding. Professors tend to forget that they were not born knowing the subject—that they once struggled just like you to understand it. View that as *their* problem, not yours! Don't be afraid to show your ignorance or to make mistakes. We generally learn much more from our mistakes than from our successes.

Utilizing Tutors and Other Campus Resources. Tutors are another excellent source of the type of one-on-one instruction discussed above. Some students have a resistance to utilizing tutors, viewing the need for tutoring as an admission they are doing poorly or need help. I would encourage you to take a positive attitude toward the use of tutors, to look upon tutoring as an opportunity for you to have a dialogue with an expert in a subject that you want to learn.

Your university undoubtedly provides tutoring services through your minority engineering program, campus-wide minority student programs, or learning assistance center. In addition, your mathematics department may run a math lab, or members of your engineering honor society, Tau Beta Pi, may do voluntary tutoring as a service to the school.

Many other campus services are available to you. The office of career planning and placement can provide you with information about companies, help you prepare a resume, work with you to develop your interviewing skills, and help you find summer jobs. The counseling center can assist you with personal problems, both those related to your academics—such as lack of motivation, inability to concentrate, and test anxiety—and those that are non-academic—such as family, financial, and legal problems. The learning assistance center can help you improve your reading, writing, and study skills. Your financial aid office can inform you about scholarships and loans for which you might be eligible. Your student health center can help you with physical or emotional problems.

Most of these campus services require that you take the initiative. They will not seek you out. Part of good "academic gamesmanship," then, is for you to scope out the resources available to you and make optimal use of them.



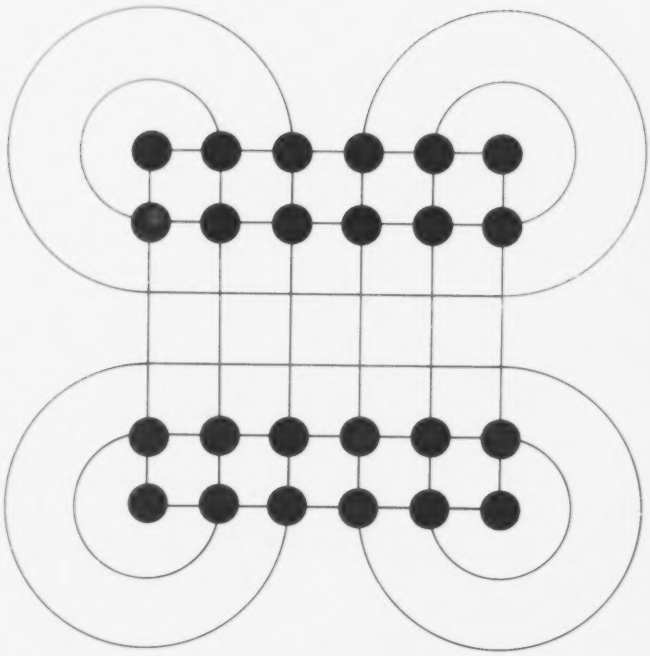
8

Develop Your Study Skills

How you do in school is a direct result of the approach you take to the process of studying and learning. Becoming a "master" student means that you have mastered the principles of good study skills and are able to put them into daily practice.

The area of study skills is extremely broad and many full length books on it have been written. Topics covered include note taking, test taking, reading for comprehension, time management, and many others. It is not my intention here to give any sort of complete coverage on this subject, but rather to emphasize a few critical ideas which, if put into practice, would dramatically enhance your academic success.

"Take it as it Comes."
I use this well-known expression to emphasize what I consider to be the *key* to success in engineering study. Put more directly, don't allow the next class session in a course to come without having mastered the material presented in the previous session. Have you ever thought of why a typical course meets for one hour three times a week for 15 weeks? The answer is obvious: we can only absorb a certain amount of material at one time, and only when that material is mastered can we go on to new material. The faculty have designed a sound educational experience in which they sequentially cover small amounts of material for you to master. However, unless you do your part, you can transform the sound educational experience into an unsound one.



Surakarta

Named after an ancient town in central Java, Surakarta pits one player using stones against another using shells. To win, players travel around the corner circles to capture opponent's pieces.

A common mistake is to study from test to test rather than from class to class. One trap you can fall into is to be lulled into a false sense of security because the teacher presents the material so clearly that you feel you understand it completely and therefore do not need to study it. But when you attend a lecture that is presented quite clearly, it only proves that the *teacher* understands the material. What is necessary is for *you* to understand it—for *you* to be able to give the lecture. In fact, that should be your goal in every class; get to the point where you could give the lecture.

To do this requires that you read your text, study your notes, solve as many problems as time permits, and discuss the subject with others. But the timing is key. For effective and efficient learning it is essential that this occur before the next class in the course. Research on learning indicates that the more efficient learning occurs the sooner studying takes place after the initial exposure to the material. Certainly, then, you should not wait for three weeks until a test is announced to begin studying the material. It is better to study the same evening rather than the next day. In fact, you should study as soon as possible after each class.

Learning is a Reinforcement Process.
Real learning and understanding only come after repeated exposure to the subject matter. The way in which we learn the subject of mechanics, the study of forces and motion, can serve as an example. Our first exposure to mechanics may have come in high school physics. Next we study a whole semester of mechanics in our first freshman physics course. In the sophomore year we may have a course in statics and in the junior year a course in engineering dynamics. If we are interested, we can take sev-

eral senior level courses and, for a thorough understanding of mechanics, we could pursue graduate study—a master's or even Ph.D. degree. Even then, if we were to begin teaching mechanics, we would find areas where we were not completely clear and probably only after a number of years of teaching would we feel that we had total mastery of just the basics of the subject. Even for the brightest person, learning is a slow process that occurs over time and relies on reinforcement.

The educational system is structured to offer you the opportunity to reinforce the subject matter many times within the semester. Only by taking advantage of these opportunities will you achieve a satisfactory level of learning. Your first exposure to the material comes when you read over the material prior to the lecture. The lecture is then a first reinforcement. To get the most out of the lecture, sit near the front, concentrate on the material being presented, and take thorough notes. Good note taking is an art, as you have to balance the processes of taking notes and listening at the same time. Writing down the material will further reinforce learning, and good notes will provide you a record of what the professor feels is important.

As previously discussed, study the material as soon as possible after the lecture. Review and annotate your notes; read any text material related to the lecture; and work problems—as many as you can. Solving one or two problems, even though that may be all the professor assigned, will not ensure an adequate level of understanding. If time permits work *all* of the problems in the book. If more time is available, work them a second time. Practice, practice, practice! The more problems you solve, the more you will learn. Most of the learning in math, science, and engineering courses comes not from studying or reading but from solving problems.

Once you have done these things, you will be ready for the next class meeting. You will have already had a number of reinforcements of the material. Later you will again reinforce the material when you review for a test and still later when you study for the final exam.

How Many Hours Should You Study?

Once you commit to keeping up in your classes and taking advantage of each opportunity to reinforce the learning process, you must determine how many hours of study to put in to master the material covered in a one-hour lecture. I'm sure you've heard the standard rule-of-thumb that you should study two hours out of class for every hour in class. No way! This is a gross oversimplification. The answer is that you should put in whatever amount of time you need. For demanding technical courses it is doubtful that two hours are enough; the correct number for you may be three, four, or even five hours.

Even though it is difficult to assess initially, I suggest that you come up with a number for each of your classes. In making this determination, you will have to consider such factors as how difficult the course is, how good a student you are, how well prepared you are for the course, and what grade you want to receive. Making an "A" will take a lot more effort than making a "C."

Once you have decided that, for a particular course, you should study say three hours between each class meeting, and you realize that the best time to do this studying is as soon after you have attended the lecture as possible, you have done the easy part. The hard part is actually doing it. Putting these approaches into practice requires you to be an organized person and an expert at managing your time.

Learn to Manage Your Time.

Everyone from the president of IBM to a bum on skid row has exactly the same amount of time—to be precise, 168 hours per week. There is no point in saying that you have no time because you have just as much as anyone else. Some people, however, accomplish a great deal with their time and others accomplish virtually nothing.

Your effectiveness as a student will be greatly enhanced by scheduling your time. The approach I took when I was a student was to sit down each Sunday night with a form like the one on page 19 and schedule my entire week.

To use this form, first write down all your commitments: classes, meetings, job, time to get to and from school, time for meals, and so forth. The rest of the time is available for one of two purposes: study or recreation.

Next, schedule blocks of time to study. You have already decided how much time you need between each class meeting and you know the advantages of scheduling it as soon after the class meeting as possible. Write down both *where* and *what* you will study. Students tend to waste too much time between classes making three decisions: Should I study now or later? Where should I study? What should I study? By making these decisions in advance, you will improve your efficiency tremendously.

Once your study time is scheduled, check to see if you've left open some time for recreation. If not, you probably are overcommitted; you have taken on too much.

One of the advantages of making a schedule is that it gives you a graphic picture of your situation. Remember don't "program yourself for failure." Be realistic about what you can handle. If you are overcommitted, you may want to choose to let something go. Reduce your work hours or your extracurricular activities or reduce the number of units you are taking.

Making up a weekly schedule, you will find, is easy and fun. But sticking to it will be a challenge. The key is to make a serious commitment to your study time. I'm sure you take your class time as a serious commitment. If for example, five minutes before a class a friend asked you to go to the student union, you would say "No, I have a class." But what about your study time? What if the same friend came up to you just as you were about to go to the library to study? I would encourage you to make the same commitment to your scheduled study time as you do to your class time. After all, much more learning occurs out of class than in. Every time you put off an hour of studying you are borrowing time from the future, time which will not be there.

To monitor yourself, mark in red on your schedule the hours you actually study. At the end of each week you will be able to readily count up how much studying you did. If you are doing poorly in your classes, I'll bet you will see a direct correlation with the amount of studying you are doing.

Initially you may find that you have made a schedule you are unable to follow. Don't worry about that. In time, you will learn about what you can and cannot do and will become more proficient at scheduling your time.

Preparing For and Taking Tests.

As I pointed out in the introduction, the key to success in engineering study is to become a "master" at preparing for and taking tests. The best thing you can do to prepare for tests is to adopt the approaches discussed in the previous three sections. When I hear a student boast that he or she stayed up all night studying for a test, I know this is a student who is not doing well. Cramming for tests is the wrong approach. If you "take it as it comes," preparing for a test will merely involve scheduling time over several days prior to the test to review the material. You shouldn't have to cover new material when preparing for a test.

There is one major difference between doing homework and taking a test: time pressure. I would suggest that when preparing for a test, you spend a portion of your time working problems under a time limit. If you can, obtain tests from previous semesters or, better yet, construct your own exams. Creating and taking your own practice exams will give you invaluable experience in solving problems under pressure, plus it will give you the added advantage of learning to "scope out" tests. In time you will significantly improve your ability both to work under pressure and to predict what will be on tests.

Be sure to get a good night's sleep prior to a test. Arrive at the site of the test early so that you have ample time to gather your thoughts, and be sure you have whatever materials you'll need: paper, pencils, calculators, etc. A certain amount of "psyching yourself up," similar to what an athlete does prior to a big game, might be helpful; however, you don't want to get so nervous that you can't concentrate.

When you are given the test, don't start work immediately. First read over the entire test. Try to judge which are the easier problems and which are the harder ones. Many instructors grade on a "curve" so that your absolute score is not as important as how you score relative to the class average. If this is the case, it is important that you also try to size up the overall difficulty of the test and make a guess as to what the class average on it will be. In fact, jot down your estimate so that you can compare it later with the actual outcome. Through this process, over time you will become adept at sizing up tests. You will be able to recognize that on one test, it may take a score of 90 to get an "A," while on another test 50 may be an "A." Knowing that you only need to get one-half of the problems correct will greatly affect the way you approach a test.

Once you have sized up the test, don't start with the first problem; start with the easiest one. As you work the easiest problems and accumulate points, your confidence will build and you will develop a certain momentum. Maintain some awareness of time. By dividing the time available by the total number of problems, you will know how much time to spend on each. Try to complete a problem before leaving it, and avoid jumping from problem to problem since you'll waste time getting restarted. Be sure to check your work carefully, as careless mistakes can be very costly. It is probably smarter to work three of five problems perfectly than to do all five carelessly. Never leave a test early. Where do you have to go that is more important than achieving the highest possible score on a test? If you have extra time, check and recheck. No matter how many times you proofread a term paper, mistakes can still be overlooked. The same is true for a test.

9

Take Care of Yourself Personally

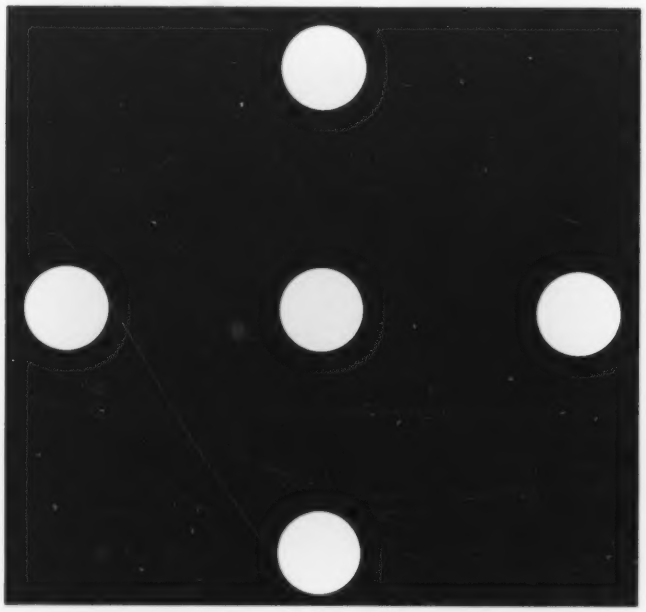
To be productive and happy, it is important that you take care of yourself personally. With the rigors and demands of being a student, it is easy to ignore your emotional and physical well-being. But that is a big mistake! Tending to your personal needs is a must.

Many people are not aware of the interrelationship between our physical and emotional health. The fact is they are strongly interrelated: our physical well-being greatly affects our emotional state—and vice versa. For example, one of the best remedies for emotional stress is vigorous physical exercise. And I'm sure you've noticed that when you are mentally "up," you tend to feel good physically, whereas if you're emotionally down, you often feel physically fatigued or even get sick.

Since each of us is so unique and our emotional and physical states so complicated, this section is only meant to point out a few ideas for your consideration. Most obviously and most importantly, to expect a high level of mental and physical health, it is essential that you:

- Eat nutritionally.
- Engage in regular aerobic exercise.
- Get adequate sleep.
- Avoid drugs.

What you eat significantly affects your physical and mental state. A proper diet consists of fresh fruits and vegetables, lean meat in moderation, and whole grain products. Avoid processed foods, fatty foods, and sugar. Not only will you feel better now but you'll reduce your chances of heart attack, cancer, and other diseases later.



Nyout

Still a popular gambling game today, Nyout had its beginnings in Korea about 1000 B.C. The successful player is first to race each piece—or horse—around the course and off the board.

Regular aerobic exercise in which you get your heart rate above 130 beats per minute for more than 20 minutes at least three times a week is essential to good physical condition. If you're not already engaged in some form of exercise, you should consider taking up jogging, brisk walking, swimming, biking, rowing, aerobic dancing, or any vigorous activity that will improve your physical fitness and that you can do regularly.

Different people require different amounts of sleep and the amount needed may change as you grow older. Only you can determine how much sleep you need. Just remember that your work efficiency will decrease if you are getting either less *or* more sleep than you need.

Drugs are abundant in our society. Some, such as caffeine, alcohol, and nicotine, are legal; others, such as marijuana and cocaine, are illegal. Regardless of their legality, all can be harmful and my advice to you is simple: avoid them. Not only do drugs detract from your physical and mental health, they also can greatly interfere with your ability to study.

One important aspect of your mental state is the balance you strike between immediate and future gratification. By seeking too much immediate gratification and therefore not getting your work done, you are likely to feel guilty. You'll probably then worry about the fact that you are not studying, putting yourself in a mental state in which you cannot study.

On the other hand if you work too much, too long, or too hard, you begin to feel deprived. Feelings of deprivation and resentment can begin to sabotage your commitment. You may begin to doubt whether the sacrifice is worth it.

What you need to find is a proper balance between work and play. One approach is to reward yourself whenever you work. Rewards can be small things, like taking a break, going for a walk, watching your favorite TV show, taking an hour for recreational reading. Or they could be larger things, such as going to a party, buying yourself some new clothes, or going away for the weekend with a friend. The point is that, rather than take the view that the work you are doing will not have a payoff until far into the future, you provide yourself with frequent and immediate rewards for your hard work.

Conclusions

You are at a crossroads in your life. One road leads you to graduation as a professional engineer. A rewarding and challenging career will be yours. The opportunity to have control over your life, to have choices, to be well paid, to be a professional, to command respect, to travel, to meet and work with interesting people, to contribute in a meaningful way to solving society's problems—all this and much more can be yours. The other road is the one followed by the many students who are unwilling to pay the price, to make the personal sacrifice, to work, to struggle, to persist; who give up and drop out.

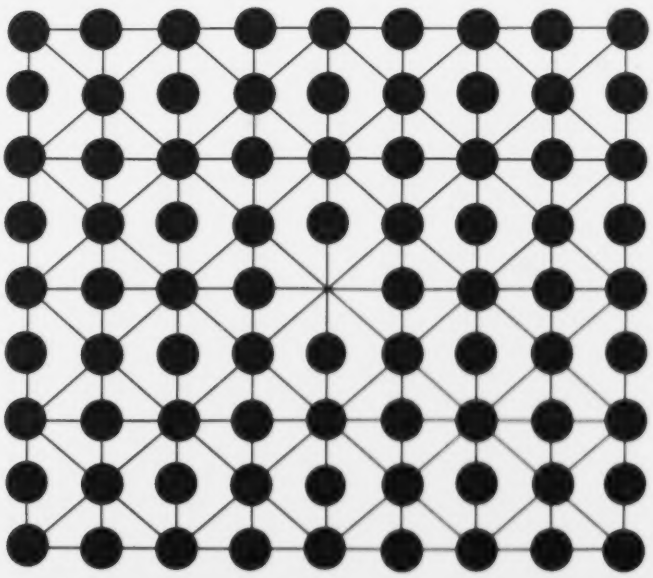
Each year commencement is a very rewarding and happy time for me. It is such a thrill to see students at the point of graduation: so proud, so happy, so pleased with themselves and their accomplishments. It's not that these students were without frustration along the way. Many experienced setbacks and failures but rose up and overcame them. Many wanted to give up but didn't and they prevailed! The joy on their faces at the graduation ceremonies shows that everything was worth it.

Then there are those occasions when one of my students who dropped out will come back to see me. It saddens me to hear that they wish they had stuck it out. That they're working in an unrewarding job for barely above minimum wage. That they would like to come back to school but now have family responsibilities and can't see any way to do it.

The purpose of this book is to encourage you to take the road that leads to graduation in engineering and to guide you in travelling that road. The opportunity to write down ideas that I have been teaching students for some years has been very rewarding for me. If they bring something of value to you, my reward will be even greater.

Zamma

Zamma boards were originally drawn in the sand in North Africa's Sahara with pieces referred to as 40 "men" and 40 "women." The winning player is the one who captures all of the opposing pieces.



Recommended Reading

Browne, Lee F. *Developing Skills for Coping.* Pasadena: California Institute of Technology (available from the author c/o Cal Tech, Pasadena, CA 91125)

Cooke, Lloyd M. *Design for Excellence: How to Study Smartly.* New York: National Action Council for Minorities in Engineering (available from NACME, 3 West 35th Street, New York, NY 10001)

Penick, Benson E. "Ten Steps to Success: How to Succeed in Engineering School." *The Black Collegian,* December 1982

Student Schedule Form

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8-9							
9-10							
10-11							
11-12							
12-1							
1-2							
2-3							
3-4							
4-5							
5-6							
6-7							
7-8							
8-9							
9-10							

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